PAN-PACIFIC ENTOMOLOGIST
October 1982, Vol. 58, No. 4, pp. 319–325
Published 30 December 1983

NOTES ON THE BIOLOGY OF *AEGIALIA HARDYI* GORDON AND CARTWRIGHT (COLEOPTERA: SCARABAEIDAE)

R. W. Rust and L. M. Hanks[1]
Department of Biology, University of Nevada–Reno, Reno 89557

Aegialia hardyi Gordon and Cartwright is a large (4.5 mm, 2.5 mg) species in the genus and is endemic to Sand Mountain and Blow Sand Mountains, Nevada. This species is flightless, a detritivore and winter active in both the adult and larval stages. The present study details portions of the life history and biological characteristics of this sand obligate *Aegialia*. We also compare its known life history characteristics to other species of *Aegialia*.

The genus *Aegialia* contains 24 species in North America (Stebnicka, 1977). Species of *Aegialia* (s. str.) are associated with sand habitats (Jerath and Ritcher, 1959; Gordon and Cartwright, 1977). Jerath and Ritcher (1959) reported that *A. blanchardi* Horn was found by sifting sand around and beneath the roots of vegetation on sand dunes near Waldport, Oregon. They also found the adults of *A. lacustris* LeConte, *A. latispina* LeConte and *A. conferta* Horn from sand dunes near Corvallis, Oregon. Jerath (1960a) reported *A. crassa* LeConte and *A. punctata* Brown from Oregon sand dunes as well. Jerath (1960b) described the larvae of *A. blanchardi* and *A. lacustris*. Recently, Gordon and Cartwright (1977) described some new *Aegialia* (s. str.) adding four new species of which three are endemic to sand dunes in Nevada (*A. hardyi* endemic to Sand Mountain, *A. magnifica* Gordon and Cartwright endemic to Big Dune, and *A. crescenta* Gordon and Cartwright endemic to Crescent Dune), and a fourth from California.

Study Areas

Two Nevada sand dunes were sampled from June 1979 through July 1980 for arthropods. Sand Mountain is approximately 46 km ESE of Fallon, Churchill County, Nevada (39°20′N, 118°20′W) at 1250 m elevation. Blow Sand Mountains are approximately 52 km SE of Fallon, Nevada (39°10′N, 118°35′W) and are at about 1400 m elevation. The two dunes are separated by approximately 25 air kilometers. Sand Mountain is a star dune of approximately 3.2 km^2 while Blow Sand Mountains are complex star and linear dunes of approximately 9.2 km. Both dunes result from the same eolian sand deposited during the Turupah and Fallon formations of about 4000 years B.P. (Morrison and Frye, 1965). Sand Mountain has easy access and is a popular recreational area while Blow Sand Mountains have extremely

limited access and little recreational use; three-fourths of the dune is located in a restricted travel area under the jurisdiction of the U.S. Navy.

The floras of the two dunes are similar. The dominant vegetation is *Atriplex confertifolia* (Torr. and Frem.), *Tetradymia tetrameres* (Blake), *Chrysothamnus viscidiflorus* (Hook.), *Astragalus lentiginosus* Dougl. and *Psoralea lanceolata* Pursh, and at Sand Mountain only, *Eriogonum kearneyi* Tidestr. and *Psorothamnus polydenius* (Torr. ex. S. Wats.). The dominant grass is *Oryzopsis hymenoides* (R. and S.).

Materials and Methods

Field sampling.—Adults and larvae of *Aegialia hardyi* were collected by sifting sand. Surface sand to a depth of 0.4–0.5 m, both from beneath dune vegetation and from non-vegetated areas, was sifted through 12 × 12 mm and 1.5 × 1.5 mm mesh screens. Approximately 0.005 m^3 of sand were sifted at a time. The dunes were sampled twice monthly from October to May for adults and larvae, except in December and January when they were sampled only once. Blow Sand Mountains were not sampled in November because of severe weather conditions. Within one sample period four or five different areas on the dunes were sampled and in any one area sand beneath all vegetation types present were sampled as well as pure sand (no vegetation). The presence of beetles in each vegetation type was recorded. Direct observation of surface active beetles was also attempted during both days and nights of a sampling period. Pitfall traps of both 24 hr and 30 day types also were employed.

Reproductive and food analyses.—During each sampling period at Sand Mountain 20–30 adult beetles were preserved in ethyl alcohol and acetic acid (≈10:1). These individuals were sexed, the females dissected and their ovarian development and the number of ova present recorded. The digestive tracts of both males and females were crushed and mounted on microscope slides and examined for food content.

Laboratory rearing.—Adults and larvae of *A. hardyi* were returned to the laboratory for rearing. The individuals used were from Sand Mountain and were obtained by sifting. Adults were obtained in November, December and January and the larvae in April. Four or five beetles were placed in 95 cc plastic cartons 9/10th filled with Sand Mountain sand and detritus. A glass tube (9 mm dia.) was placed in the center of the sand and functioned as a watering tube. Cartons were watered at about two week intervals with about 20–25 ml water. This kept the bottom 3–4 cm of sand moist. Cartons were kept at 24° ± 4°C and under (45 cm) growlux fluorescent tubes on natural day length.

Climatological data.—Mean monthly temperatures were obtained from the closest reporting station at Fallon, Churchill County, Nevada, approximately 50 km distance.

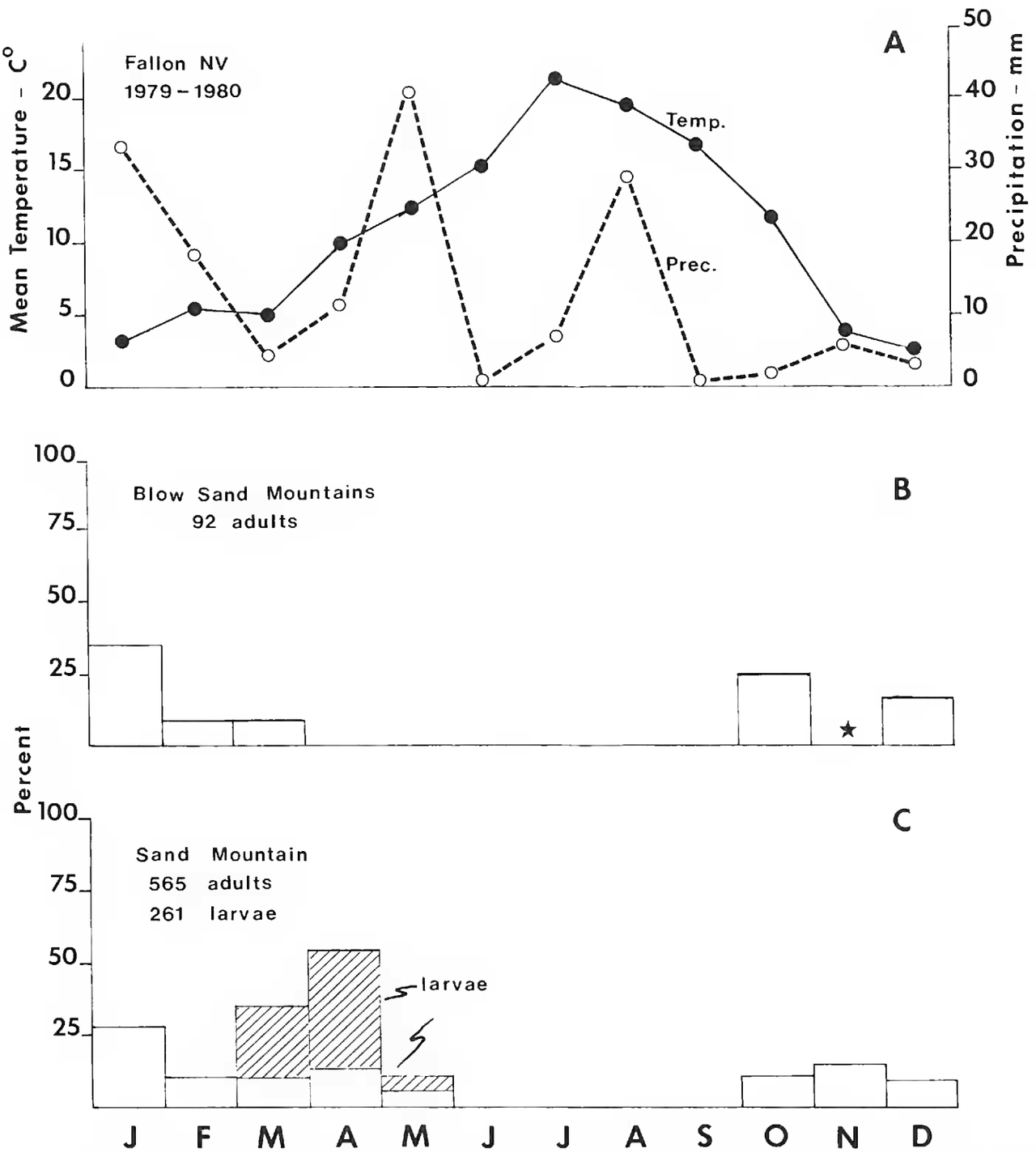

Fig. 1A–C. Seasonal distribution of *Aegialia hardyi* Gordon and Cartwright from Nevada sand dunes. Fig. 1A. Mean monthly temperature and precipitation from Fallon for the survey period. Fig. 1B. *Aegialia hardyi* distribution from Blow Sand Mountains (⋆Blow Sand Mountains not sampled). Fig. 1C. *Aegialia hardyi* distribution from Sand Mountain.

Results

Seasonal distribution.—Aegialia hardyi adults were first found in February, March and April of 1979 during preliminary sampling of the dunes. Adults were next collected in late October 1979. The abundance of adults was fairly constant during the next six months (Fig. 1B, C) with a slight

Table 1. Reproductive conditions of female *Aegialia hardyi* Gordon and Cartwright from Sand Mountain, Churchill County, Nevada, collected from November 1979 to May 1980.

	Ovarian development	Eggs present	Number examined
November	no	no	7
December	yes	yes	4
January	yes	yes	3
February	yes—no	yes—no	5 (2–3)
March	yes—no	yes—no	5 (2–3)
April	yes—no	yes—no	4 (1–3)
May	no	no	4

increase in January at both dunes. Beetles were found as late as early May at Sand Mountain. Larvae were found only at Sand Mountain in March, April and May (Fig. 1C). In March several instars were present, the first instar larvae are most likely present in February but simply were overlooked or lost in the sifting process. No pupae were found. Adults and larvae were found in months having a mean monthly temperature near to or below 10°C (Fig. 1A).

After the sand was sifted away and the remaining detritus spread out on a tray for examination, adult beetles present began crawling through the detritus and so were easily collected. This activity was observed even when the air temperature was around 5°C. Larvae showed the same activity.

Ova were present from December through April (Table 1). All females examined from December and January contained ova and there was a steady decline to a low of 25% in April. No ovarian development was observed in the females from November and May. These ova were approximately 0.7 mm long by 0.3 mm wide. Twice, 3-0 and 3-2 ova were the observed number. Additional developing ova were observed in all females with "mature" ova present. The sex ratio was slanted towards males (1:0.73).

Dune distribution.—Both adults and larvae of *A. hardyi* were found in sand removed from the bases of emergent-shrub and grass vegetation on the dunes. Beetles were taken most often from beneath *Tetradymia tetrameres* (56 samples: 41 with and 15 without) followed by *Chrysothamnus viscidiflorus* (28/13) and *Eriogonum kearneyi* (26/15). They were rarely taken from beneath *Atriplex confertifolia* (12/25), *Oryzopsis hymenoides* (12/37) and *Psoralea lanceolata* (11/21) and never were found in sand associated with *Psorothamnus polydenius* (0/17) or in non-vegetated sand (0/89). Both the larvae and the adults showed extremely clumped distributions, larvae more so than adults. For example, several times sand was removed from three sides of a *Tetradymia tetrameres* bush with beetles collected only in one of the three samples, or sparingly in the other two. Three samples from beneath

one *Chrysothamnus viscidiflorus* bush produced 27, 0, and 0 *Aegialia* adults; all three samples were taken within a 4 m^2 area about the bush. From an area of approximately 0.2 m^2 beneath a *Tetradymia* bush, 100+ larvae were taken and sampling from beneath the three sides of the bush produced no additional larvae. Single adults were rarely found in a sample.

Adult beetles were less commonly found at Blow Sand Mountains with no adults unearthed in April and May 1980 nor were larvae ever found. We suspect that this was due to the portion of the dunes available to us for sampling, the linear dune type or to both conditions.

Adults and larvae were always found in moist sand and neither were seen on the surface of the sand. Only one adult was obtained by pitfall sampling of the dunes and it was taken in one 30 day pitfall trap.

Laboratory rearing.—Adult beetles, after a short adjustment period of about a week during which individuals injured in capture died, lived for an average of 120 days in the laboratory (longest recorded, November 2 to March 24; 142 days). All adults were dead in June and no larvae were found in the cartons with captive adults. Larval beetles lived less than one week in the laboratory and most died within 24 hr after collecting. No larvae lived long enough to pupate. Adults were observed moving about on the surface of the sand between 2000 and 2200 hr on several occasions during January and February. On 23 January, 7 of 23 cartons with adults had one or more beetles active at 2100 hr. All 23 cartons were watered on the 24th; no more beetle activity was observed. This same event occurred on February 6 and 7. Twice during the 6 months of attempted rearing adults were active during daylight hours (0900 and 1000 hr), on 16 and 19 November.

Examination of cartons indicated that adult beetles were found within a centimeter or two of the moist sand-dry sand interface. The exception being the surface active beetles in 'almost' dry sand cartons. Dead larvae were found throughout the moist sand and only rarely in dry sand. This along with their high mortality rate suggests that soil moisture is much more critical to the larvae than adults.

Food habits.—*Aegialia hardyi* adults and larvae feed on detritus trapped in the sand that accumulates around emergent vegetation. Gut analyses showed plant fibers from stems, sclereids from stem pith, spongy parenchyma from leaf tissue and tracheids from stems. The cells and tissue clumps measured up to a maximum of 25 μ. The fungi *Cladosporium, Stemphylium, Alternaria* and *Torula* were common in gut contents. These fungi are associated with decay of plant materials. Whether or not these fungi serve as food for the beetles is open for speculation. It is possible that the plant material is the carrier of the actual food, the fungal mycelium; a situation similar to that found in freshwater detritovores (Cummins, 1974). *Cladosporium* and *Alternaria* were very abundant outnumbering the plant tissue fragments in the guts of several adult beetles. Some of the beetles carried pollen grains in their gut contents. One was identified as *Pinus monophylla*

Torr. and Frem., Pinyon Pine; the closest Pinyon in a windward direction is over 50 km away. One gut contained insect integument, setae easily visible; perhaps pupal or larval exoskeleton. There was no apparent difference in the food selected by adults and larvae. Adults from November had empty digestive tracts while all others were full.

Discussion

Aegialia hardyi is similar to some species of *Aegialia* (s. str.) in its association with sand habitats. However, these sand habitats may be wet sand, as along streams. It is different in having a winter activity period for both adults and larvae. *Aegialia blanchardi* adults were found year round and the larvae in the early summer (May to July) (Jerath, 1960b). *Aegialia lacustris, A. latispina* and *A. conferta* were found during the summer months and their larvae were found in the early summer (Jerath and Ritcher, 1959). These researchers found adults, pupae and larvae just below the surface ("6 to 8 inches") by sifting sand. They also reported the larvae to feed only on decaying organic matter in the sand.

The winter activity period of *A. hardyi* may result from the limited precipitation and hot summer temperatures found in these Great Basin sand dunes. Although there are summer rain storms, the seasonal distribution of the 10 to 15 cm of precipitation in the Fallon area is principally winter (Houghton et al., 1975). Also, there is over an eighty percent chance of no measurable precipitation during early August in the Sand Mountain and Blow Sand Mountains areas. Of the 15.8 cm of precipitation falling during the survey period, 76.6% fell between October 1979 and May 1980 (Fig. 1A). The 30 mm of rain in August represents an unusual climatological event not typical over extended years. The addition of new litter to the sand also would be at a maximum rate during the fall months at the onset of the adult activity period. Competition with other summer active detritovores also may have narrowed the activity period or at least shortened it. Finally, all three factors may be important in the sequence of steps resulting in the winter activity period.

Acknowledgments

We would like to thank Bob Bechtel for his assistance with the project and his review of the manuscript. Dr. Don Prusso identified the fungi and plant parts. Also, the review comments of Drs. Fred Andrews, Bob Gordon and Alan Hardy were most helpful. Bob Gordon identified the *Aegialia* specimens. We would like to thank Dave Goicoechea, BLM State of Nevada, for his support in making the study possible.

Literature Cited

Brown, W. J. 1931. Revision of the North American Aegialiinae (Coleoptera). Can. Entomol., 63:9–19, 42–49.

Cummins, K. W. 1974. Structure and function of stream ecosystems. BioScience, 24:631–641.

Grodon, R. D., and O. L. Cartwright. 1977. Four new species of *Aegialia* (s. str.) (Coleoptera: Scarabaeidae) from California and Nevada Sand Dunes. J. Wash. Acad. Sci., 67:42–48.

Houghton, J. G., C. M. Sakamoto, and R. O. Gifford. 1975. Nevada's weather and climate. Nev. Bur. Mines Geol. Spec. Publ., 2:1–78.

Jerath, M. L. 1960a. Distribution of Aphodiinae in Oregon. Pan-Pac. Entomol., 36:183–188.

———. 1960b. Notes on larvae on nine genera of Aphodiinae in the United States (Coleoptera: Scarabaeidae). Proc. U.S. Nat. Mus., 111(3425):43–94.

———, and P. O. Ritcher. 1959. Biology of Aphodiinae with special reference to Oregon. Pan-Pac. Entomol., 35:169–175.

Morrison, R. B., and J. C. Frye. 1965. Correlation of the middle and late quarternary successions of the Lake Lahonton, Lake Bonneville, Rocky Mountains (Wasatch Range), southern Great Plains, and eastern midwest areas. Nev. Bur. Mines Rep., 9:1–45.

Stebnicka, Z. 1977. A revision of the world species of the tribe Aegialiini. Acta Zool. Cracov., 22:397–506.

Footnote

[1] Present address: Department of Entomology, University of Maryland, College Park, Maryland.